

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Derek Raybould et al. : Confirmation No.: 1262
Serial No. 10/621,071 : Group Art Unit: 1793
Filed: July 14, 2003 : Examiner: Kiley Shawn Stoner

For: LOW COST BRAZES FOR TITANIUM

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Sir:

This is an appeal from the final rejection dated as mailed on April 23, 2007 and the Advisory Action, dated as mailed on July 30, 2007. The period of response extends to and includes October 22, 2007.

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REAL PARTY IN INTEREST

The real party in interest in the present case is the assignee, Honeywell International, Inc.

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RELATED APPEALS AND INTERFERENCES

There are no prior or pending appeals or interferences for the present case.

STATUS OF CLAIMS

Claims 18-20 and 22-29 stand rejected. Claims 30-37 are allowed. Claims 1-17, 21 and 38-44 were canceled previously without prejudice or disclaimer of subject matter. Claim 45 is withdrawn by the Examiner. Claims 18-20 and 22-29 stand or fall together. A listing of the claims may be found in the Claim Appendix on page 21 of this brief.

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STATUS OF AMENDMENTS

No amendments were filed subsequent to the last office action, an advisory action mailed July 30, 2007.

SUMMARY OF CLAIMED SUBJECT MATTER

Independent Claim 18

The embodiment of the present invention described in claim 18 provides a method of brazing a titanium metal, wherein the method comprises the following steps (with reference to the originally filed application disclosure in parenthesis):

coating a braze material onto a base material (paragraph [044], for example). The braze material may be a mixture of Ti, Cu, Ni powders comprising 25-80% by weight Ti (paragraph [031], for example), 12-24% by weight Ni (paragraph [031] and claim 1, for example), and 12-22%Cu (paragraph [031] and claim 1, for example), wherein the Cu/Ni is between 0.5 and 1.0 (paragraph [039] and claim 1, for example), and wherein the amount of Zr present in the braze material is from 0 (paragraph [039], for example, describing the Zr as optional) to not more than 12 wt% (claim 2, for example);

placing the base material with the braze material in a vacuum furnace (paragraph [046], for example);

heating the braze material and the base material for a given braze time to achieve thermal stability between the braze material and the base material, the heating being up to a temperature that is not more than a braze temperature of the braze material (paragraph [046], for example); and

forming a braze joint between the braze material and the base material (paragraph [046], for example).

GROUND OF REJECTION TO BE REVIEWED ON APPEAL

Are claims 18-20 and 22-29 novel and not anticipated under 35 U.S.C. §102(b) by Vollmer, U.S. Patent No. 6,149,051 (hereinafter referred to as “the Vollmer patent” or simply “Vollmer”)?

Are claims 18-20 and 22-29 patentable and nonobvious under 35 U.S.C. §103(a) over the Vollmer patent?

ARGUMENTS

Rejection under 35 U.S.C. §102(b) over Vollmer, U.S. Patent No. 6,149,051

Claims 18-20 and 22-29 have been rejected under 35 U.S.C. §102(b) as being anticipated by Vollmer, U.S. Patent No. 6,149,051 (hereafter referred to as “the Vollmer patent” or simply “Vollmer”). Vollmer discloses a braze material comprising “substantially only a Ti-Cu-Ni-Zr mixture” (Vollmer at column 3, lines 57-58). The braze material may include “about ... 15 wt% Zr” (Vollmer at column 5, lines 40-41). Preferably, the braze material may comprise 40Ti-20Cu-20Ni-20Zr (Vollmer at column 5, lines 41-43). The Examiner asserts that “about 15 wt%” as used in Vollmer “anticipates and encompasses” not more than 12 wt% as instantly claimed (Final Office Action at Page 4, lines 2-3).

The present invention is drawn to a braze for titanium. Applicants have discovered a braze and brazing method wherein costly Zirconium (Zr) present in the braze may be reduced or preferably eliminated (to not more than 12 wt% as claimed).

The braze material of the present invention includes Zr in an amount “from 0 to not more than 12 wt%”, as presented in claim 18, which is at a weight percent less than the range indicated by the teachings of Vollmer (about 15-25 wt%, Vollmer at column 5, lines 40-41). Thus, the braze material of Vollmer differs from that used in the present invention, as described in claim 18, as amended. Because Vollmer differs from the present invention in at least one element, Applicants respectfully request reconsideration and withdrawal of the rejection of the claims as being anticipated under 35 USC 102(b) by Vollmer.

In a previous telephone interview with the Examiner, the Examiner expressed a position in which the lower limitation of “about 15 wt%” of Vollmer may be read to anticipate the upper limitation of “not more than 12 wt%” as instantly claimed. Applicants respectfully disagree for the following reasons.

It is well established that “anticipation under § 102 can be found only when the reference discloses exactly what is claimed.” Titanium Metals Corp. v. Banner, 778 F.2d 775, 227 USPQ 773 (Fed.Cir. 1985). Therefore, to maintain a rejection of the claims (which require “not more than 12wt% Zr”) as being anticipated by Vollmer (which disclose Zr from about 15-25 wt%), the term “about” must be read, in the phrase of “about 15-25 wt%”, to be the same as disclosing 12 wt%. Applicants believe such an interpretation of “about” in this case is improper.

“About” in Vollmer cannot allow a 20% change in degree of a claimed element

When a term of degree is present in a patent application, the patent Examiner must determine whether a standard is disclosed or whether one of ordinary skill in the art would be apprised of the scope of the claim. Titanium Metals Corp., 778 F.2d 775, 227 USPQ 773. In the present case, no standard appears to be present to define the term “about” in the Vollmer patent. Therefore, under the presumption of validity of the Vollmer patent, the scope of the term “about” must be able to be apprised by one of ordinary skill in the art. As discussed below with reference to the rejection under 35 USC 103, one of ordinary skill in the brazing arts would not even consider, in their broadest interpretation, that “about 15 wt% Zr” would mean 12 wt% Zr, as would be necessary for the Examiner to maintain a rejection under 35 USC 102(b). By holding such an interpretation of “about 15 wt%”, one must imagine that the “about” term of degree may allow **differences of 20%** from the actually

disclosed term itself ($15-12 = 3/15 = 20\%$). It is Applicant's position that, especially in the brazing arts, that such a reading of the term "about" would practically never be an interpretation of one of ordinary skill in that art. For this reason alone, Applicants take the position that the instant claims are not anticipated by Vollmer.

12 wt% is not disclosed in Vollmer with sufficient specificity

When the prior art discloses a range which touches, overlaps or is within the claimed range, but no specific examples falling within the claimed range are disclosed, a case by case determination must be made as to anticipation. In order to anticipate the claims, the claimed subject matter must be disclosed in the reference with "sufficient specificity to constitute an anticipation under the statute." *Id.* Assuming, *arguendo*, that the Examiner maintains that "about 15 wt%" touches on a claim of "not more than 12 wt%", Applicants maintain that a rejection under 35 USC 102 is still improper, as there is not any "sufficient specificity" in Vollmer to support a disclosure of "not more than 12 wt% Zr" as instantly claimed.

Response to Examiner's arguments in the Advisory Action

With all due respect, Applicants submit that the Examiner's logic presented in the Advisory Action is legally and scientifically flawed. One aspect of the declaration (paragraph 11 of each of the declarations dated January 25, 2007 and June 18, 2007) of the inventor describes that "brazing chemistry must be tightly controlled and typically is specified to $\pm 1\%$ for critical elements, such as Zr." The Examiner takes this 1% tolerance and applies it to the bottom of the range of the Vollmer patent (15 wt%) to get 14 wt%. The Examiner again takes this 1% tolerance and applies it to the upper end of the range of the

instant application (12 wt%) to get 13 wt%. Still further, the Examiner applies this 1% tolerance to the 14 wt% from Vollmer (after the first 1% tolerance of 15% to get 14 wt%) to get 13 wt% for Vollmer. From this, the Examiner concludes "Vollmer's broad disclosure of about 15% clearly overlaps 12% and it's [sic] positive +1% tolerance, and is therefore further proof that Vollmer anticipates the Applicant's claim limitation. In trying to comprehend this logic, Applicants postulate that, if the range of the instant invention was not more than 8 wt%, for example, that the Examiner would simply apply this logic through 4 more cycles to "prove" that about 15 wt% from Vollmer anticipates 8 wt%. Applicants respectfully disagree with this line of reasoning to show anticipation of the instant claims.

Therefore, for the plurality of reasons discussed above, with support of the discussion below with reference to the rejection under 35 USC 103, Applicants respectfully request reconsideration and withdrawal of the rejection of the claims as being anticipated by Vollmer.

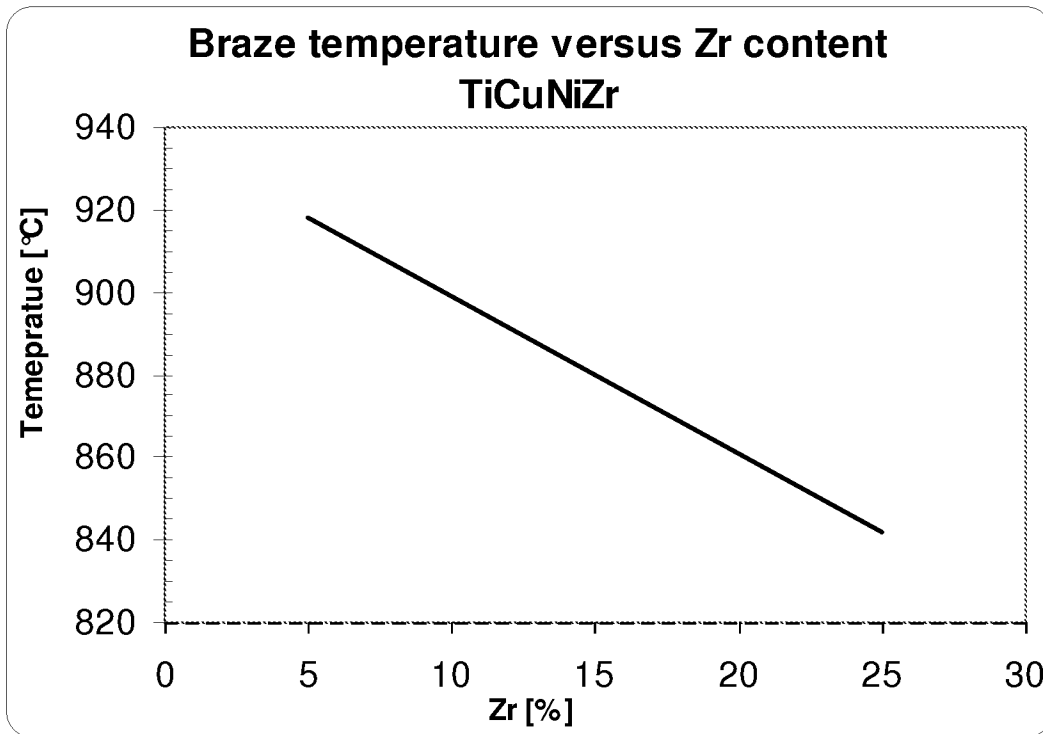
Rejection under 35 U.S.C. §103(a) over Vollmer, U.S. Patent No. 6,149,051

Claims 18-20 and 22-29 have been rejected under 35 U.S.C. §103(a) as being unpatentable over the Vollmer patent. In addressing the rejection of the claims 18-20 and 22-29 as being unpatentable under 35 USC 103(a), the Examiner notes that Vollmer discloses that the amounts of Zr present are "about ... 15-25 wt %." The Examiner takes the position, at page 5 of the Office Action, that "[w]ith respect to the claimed amount of Zr...the amounts in question are so close that it is prima facie obvious that one skilled in the art would have expected them to have the same properties." Applicants respectfully disagree with this position for the reasons outlined below.

The Examiner argues that 15 wt % Zr encompasses the maximum of the range "from 0 to not more than 12 wt %" Zr as instantly claimed. This seems to **imply that the compositions can be off by plus or minus 1/5 (20%)** of the given compositions. Therefore, it appears that the Examiner is concluding that a **20% change** in composition makeup is close enough that one skilled in the art would expect properties to be the same. Applicants respectfully disagree. Clearly, one skilled in the art would understand, as evidenced by both the declarations of Dr. Derek Raybould (dated January 25, 2007 and June 18, 2007), that such a large variation in the braze composition would lead to significant differences in braze temperatures and poor brazes or ruined parts.

Temperature is critical for brazing. In many brazing operations, temperature is kept within +/- 5°C. If this range is breached, the braze may not melt or many properties of the base material may be deteriorated due, for example, to erosion.

The Figure below shows how brazing temperature changes with changes in Zr concentration.



If we consider varying the amount of Zr present in a braze composition between the two values (15 wt% and 12 wt%) which the Examiner has concluded would be close enough to be an obvious variation, the following observations may be made. The braze material tested to generate the data for the above graph is made of a 22Ni 18Cu xZr alloy, wherein Zr is varied between 5 and 25. In making a Zr variation between 12 and 15, for example, the braze temperature of this alloy changes by about 12 °C.

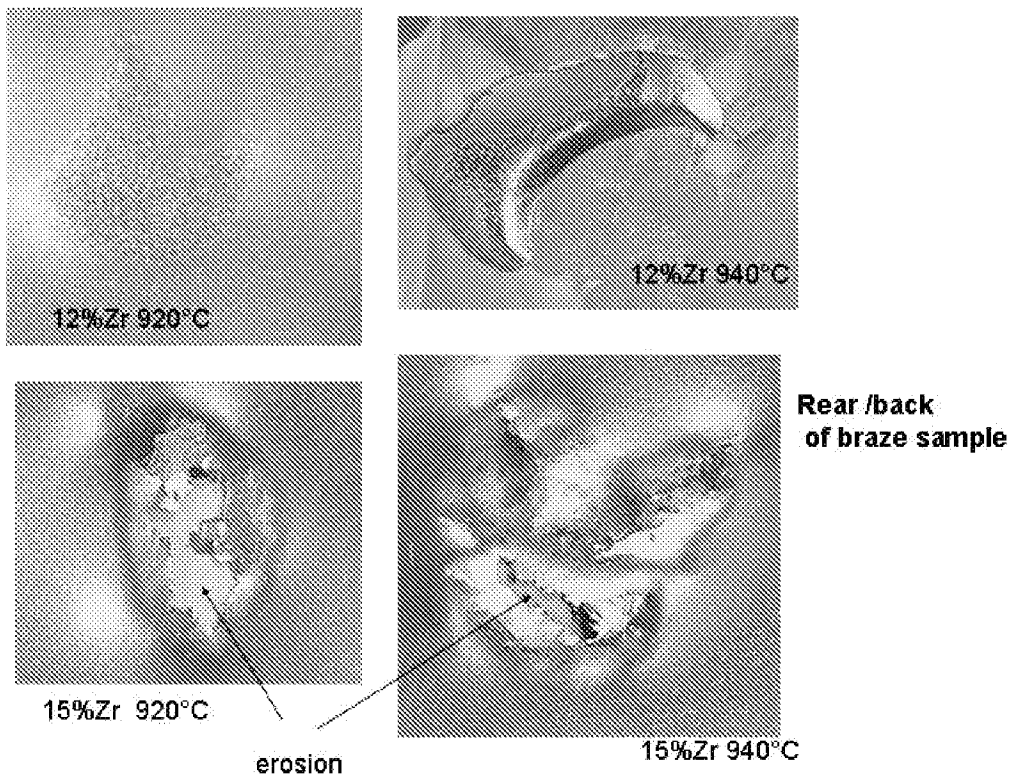
In another example, a 20Ni18CuxZr braze may show a melt temperature change of about 16 °C when the Zr amount is changed from 12 wt.% to 15 wt.%.

Braze composition [wt%]	Melt Temperature [°C]
50Ti20Ni18Cu12Zr	883
47Ti20Ni18Cu15Zr	867

As stated above, if a braze operation temperature range (generally +/- 5°C) is breached, brazability is affected because such a change in temperature may change the melt properties of the braze and/or may deteriorate the base metal due, for example, to erosion. As indicated above, a Ti/Ni/Cu/Zr braze with 12% Zr will not have the same properties as one with 15% Zr. The melt temperature, the most critical property for a braze, is different (at least 12°C) and one skilled in the art would expect this to be the case. The Examiner states that there has been no evidence provided rebutting the Examiner's statement that one would expect a 12 and 15% Zr braze to have the same properties. Applicants suggest that the above Figures shows that the melt temperature, the most important property for a braze, does vary with Zr content and that going from 12 to 15% results in a change outside the normal permitted temperature range of a braze furnace (+/- 5°C). In addition, if one were to allow such a variation in chemistry of one alloy addition, one would have to accept similar variations (20%) for the other alloying elements, thereby resulting in a very large variation in melt temperature. Therefore, Applicants respectfully submit that "not more than 12 wt%" Zr as instantly claimed is outside the scope of "15-25 wt% Zr" as taught by Vollmer.

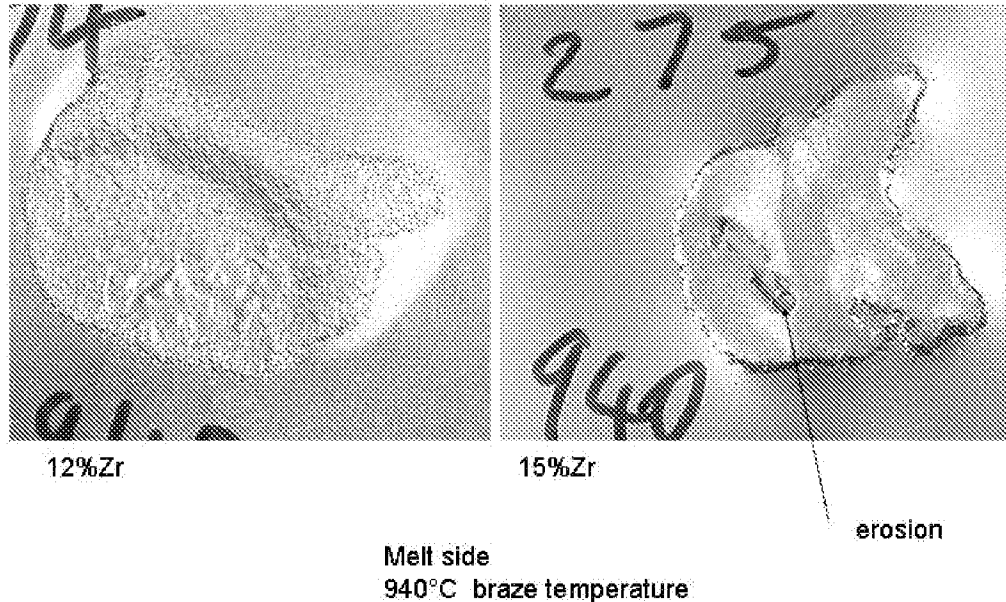
Moreover, Applicants have undergone additional studies to show that the above prepared brazes, with either 12 wt% Zr or 15 wt% Zr, give significantly different results when used at a melt temperature of at least 920°C.

The Figure below shows, in the top two pictures, a 12 wt.% Zr braze used at both 920°C and 940°C. In this case, there is no erosion of the Ti base material. However, as shown in the bottom two pictures in the figure below, a 15 wt.% Zr braze used at either 920°C or 940°C show erosion through the base material.



The figure below shows the front of the 940°C samples from the right hand part of the above figure. This figure, below, again clearly shows that erosion occurs with the 15 wt.% Zr braze at 940°C and does not occur with the 12 wt.% braze.

It is emphasized that erosion, the common term used for this problem, means that there is no material left, i.e. there is a hole.



The Examiner states, "With respect to the claimed amount of Zr, it is the examiner's position that the amounts in question are so close that it is prima facie obvious that one skilled in the art would have expected them to have the same properties." Applicants urge that, with the data submitted before the Examiner, even if one skilled in the art may think that a 3 wt.% difference would be "so close" as to be obvious, the actual properties of such "close" compositions clearly show that this not the case. Applicants, however, do not even suggest that a 3 wt.% difference in a critical element, such as Zr, is obvious to one skilled in the art, as was put forth at paragraph 11 in the declarations previously submitted.

The braze of the present invention may be used in heat exchangers intended for military aircraft. One of the heat exchangers may be intended to heat the pilot's cabin. If mixing of the hot and cold air does occur (for example, due to erosion as shown in the figures above), not only will the heat exchanger become inefficient, but also the CO from the exhaust gas may enter the cabin air, endangering the pilot, who may gradually lose consciousness. Clearly, if one having ordinary skill in the braze arts were to interpret "about 15 wt.%" to include 12 wt.%, such an interpretation may have catastrophic results.

Additionally, Applicants have submitted declarations of Dr. Derek Raybould, one of the inventors of the present application. Dr. Raybould notes "It is generally known in the art that while a wide range in braze temperature is desirable a small change (+10°C) in melt (braze) temperature will result in either no brazing occurring if the melt temperature increases, or, if the melt temperature decreases, then melting will lead to erosion of the substrate, i.e. melt through, both of which cases are unacceptable. This latter effect is of critical importance for thin sections as occur in a heat exchanger."

The Examiner suggests that "from 0 to not more than 12 wt%" Zr in the braze would be recognized as having the same properties of "about ... 15% Zr" of Vollmer. As shown in the above Figure, this change (from 15 wt.% to 12 wt.%) is significant, and results in a change in braze temperature of about 12°C. Such a change, as noted by the declaration of Dr. Raybould, is unacceptable in the brazing arts.

Furthermore, Dr. Raybould notes, "It is generally known in the art that a braze should have a solidus and liquidus temperature that are close together, preferred braze compositions are therefore eutectics or similar, which have the same solidus and liquidus. These compositions quickly melt at one

temperature, but eutectics are at the bottom of compositional troughs and a very small variation in chemistry will result in a large increase in melt temperature, i.e., the eutectic composition must be maintained, how tightly depends on the alloy.”

Finally, Dr. Raybould notes, “It is generally known in the art that braze chemistry must be tightly controlled and typically is specified to $\pm 1\%$ for critical elements, such as Zr and perhaps $\pm 3\%$ for less critical elements such as Ti. In fact, the Honeywell specification for TiCuNiZr, originally written by J. Vollmer, follows this rule and has Ti controlled at less than 3%.” Applying this $\pm 1\%$ rule to the minimum 15% of the Vollmer patent gives a minimum of 14%. Applying this rule to the maximum (not more than 12%) of this application, gives not more than 13%. So even after applying the tolerances used by Vollmer ($\pm 1\%$) there is no overlap in the wt% of Zr between the maximum and minimum chemistries. A **change of 20%** in the amount of Zr – the difference between not more than 12 wt.% (the maximum of the present invention) and 15 wt.% (the minimum of Vollmer) – would be very significant, especially as it would logically have to be applied to the other alloy additions. Such a change, as would be known to one skilled in the art, may be detrimental to braze compositions, which are eutectics or similar.

For the above reasons, Applicants respectfully request reconsideration and withdrawal of the rejection of claims 18-20 and 22-29 as being anticipated by Vollmer and as being unpatentable over Vollmer.

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CONCLUSION

Applicants submit that all claims on appeal are patentable for the reasons given above. Thus, all the pending claims should be allowed on appeal. Accordingly, the reversal of the Examiner by the honorable Board of Appeals is respectfully solicited.

In the event the Board wishes to discuss any aspect of this brief, please contact the attorney at the telephone number identified below.

Respectfully submitted,

By: / Lyman H. Smith /
Lyman H. Smith, Reg. No. 44,342
Michael A. Shimokaji
Attorney Registration No. 32, 303

Honeywell International Inc.
Law Dept. AB2
P.O. Box 2245
Morristown, NJ 07962-9806
(310) 512-4886
Attn: Oral Caglar

CLAIMS APPENDIX

1-17. (Canceled)

18. (Previously presented) A method of brazing a titanium metal comprising the steps of;

coating a braze material onto a base material, said braze material being a mixture of Ti, Cu, Ni powders comprising 25-80% by weight Ti, 12-24% by weight Ni, and 12-22%Cu, wherein the Cu/Ni is between 0.5 and 1.0, and wherein the amount of Zr present in said braze material is from 0 to not more than 12 wt%;

placing said base material with said braze material in a vacuum furnace;

heating said braze material and said base material for a given braze time to achieve thermal stability between said braze material and said base material, said heating being up to a temperature that is not more than a braze temperature of said braze material; and

forming a braze joint between said braze material and said base material.

19. (Original) A method as in claim 18, wherein said braze material is further comprised of a precious metal (PM), the (Cu+PM)/Ni ratio is between 0.5 and 1.0, and there is 54-76% by weight Ti.

20. (Original) A method as in claim 19, wherein said braze material is further comprised of a precious metal (PM) and Zr, said Ti being 42-76 wt%, said Ni being 12-24 wt%, said Cu + PM being 12-22 wt%, said Zr being 0.5-12 wt%, and the Cu/Ni ratio is between 0.75 and 1.0.

21. (Canceled)

22. (Previously Presented) A method as in claim 20, wherein said braze material is further comprised of M, wherein M is selected from the group consisting of Fe, V, Cr, Co, Mo, Nb, Mn, Si, Sn, Al, B, Gd, Ge or any combinations thereof.

23. (Previously Presented) A method as in claim 22, wherein said braze material is comprised of 30-80 wt%Ti, 12-24 wt % Ni, 10-30% Cu, and 1-20 wt% M.

24. (Original) A method as in claim 18, wherein said braze material is further comprised of (a) wt% Ti, (b) wt% Ni, (c) wt% Cu, (d) wt% Al, (d) wt% Si, (d) wt% Nb, (d) wt% Mo, (d) wt% Co and (d) wt% Fe, wherein (a) : (b) : (c) are in the ratio of 11: 5: 4 and (d) is between 0 to 10.

25. (Previously Presented) A method as in claim 18, wherein said braze material is further comprised of PM and M powders and said Ti being 25-80 wt%, said Ni being 12-24 wt%, said Cu+PM being 10-30 wt%, and 1-20 wt% M.

26. (Original) A method as in claims 25, wherein said M is selected from the group consisting of Fe, V, Cr, Co, Mo, Nb, Mn, Si, Sn, Al, B, Gd, Ge or any combinations thereof.

27. (Previously Presented) A method as in claim 18, wherein said braze material is further comprised of PM and M powders, said Ti being 25-70 wt%, said Ni being 12-24 wt%, said Cu + PM being 10-30 wt%, said M being 1-20 wt%, and the (Cu+PM)/Ni ratio is between 0.8 and 1.0.

28. (Original) A method as in claim 27, wherein M is selected from the group consisting of Fe, V, Cr, Co, Mo, Nb, Mn, Si, Sn, Al, B, Gd and Ge or any combinations thereof.

29. (Original) A method as in claim 24, wherein said braze material is further comprised of Ti, Ni, Cu, Al, Si, Nb, Mo, Co and Fe powders.

30. (Original) A method of brazing a titanium metal comprising the steps of;

coating a first braze material onto a base material, said first braze material being a mixture of powders of Ti, Cu, Ni, PM, Zr, M comprising 20-80 wt% Ti, 10-30 wt% Cu, 10-30 wt % Ni, 0-20wt %PM, 0-20 wt% Zr, 0-20% M with a Ni/(Cu+PM) ratio between 0.77-0.93;

placing said base material with said braze material in a vacuum furnace;

performing a first heating of said braze material and said base material to achieve thermal stability between said braze material and base material, said first heating being up to a temperature that is not more than a first braze temperature of said braze material;

coating a second braze material onto said base material, said second braze material being a mixture of Ti, Ni, Cu, PM, Zr, M comprising 1-20 wt% more of PM, Zr, M or combinations thereof than said first braze;

performing a second heating of said second braze material and said base material up to a second braze temperature; and

forming a braze joint between said second braze and said base material.

31. (Original) The method as in claim 30, wherein said base material is an isomorphous beta phase only titanium base material selected

from the group consisting of Ti-15 V-3 Cr-3 Sn-3 Al, Ti-15Mo-3Nb -3Al – 0.2Si, and Ti-13 V-11 Cr-3 Al.

32. (Original) The method as in claim 30, wherein said base material is a titanium metal selected from the group consisting of Ti-6Al-2Sn-4Zr-2Mo and Ti-3Al-2.5V.

33. (Original) The method as in claim 30, wherein said second braze temperature is between 10 °C and 100 °C lower than the first braze temperature, and in the range 800-900°C.

34. (Original) A method of brazing a titanium metal comprising the steps of;

coating a first braze material onto a base material, said first braze material being a mixture of powders of 20-80 wt% Ti, 10-30 wt% Cu, 10-30 wt % Ni, 0-20 wt% PM, 0-20 wt% Zr, 0-20 wt% M and a Ni/(Cu+PM) ratio between 0.77-0.93;

placing said base material with said braze material in a vacuum furnace;

performing a first heating of said braze material and said base material to achieve thermal stability between said braze material and base material, said first heating being up to a temperature that is not more than a first braze temperature of said braze material;

coating a second braze material onto said base material, said second braze material being a mixture of Ti, Ni, Cu, PM, Zr, M , said second braze material comprising 1-20 wt% more of PM, Zr, M or combinations thereof than said first braze;

performing a second heating of said braze material and said base material up to a second braze temperature; and

forming a braze joint between said second braze and said base material.

35. (Original) The method as in claim 34, wherein said base material is an isomorphous beta phase only titanium base material selected from the group consisting of Ti-15 V-3 Cr-3 Sn-3 Al, Ti-15Mo-3Nb -3Al – 0.2Si, and Ti-13 V-11 Cr-3 Al.

36. (Original) The method as in claim 34, wherein said base material is a titanium base material selected from the group consisting of Ti-6Al-2Sn-4Zr-2Mo and Ti-3Al-2.5V.

37. (Original) The method as in claim 34, wherein said second braze temperature is between 10 °C and 100 °C lower than the first braze temperature, and in the range 800-900°C.

38-44. (Canceled)

45. (Withdrawn) A method as in claim 27, wherein said Zr being 0.0 wt% and M is selected from the group consisting of Fe, V, Cr, Co, Mo, Nb, Mn, Si, Sn, Al, B, Gd and Ge or any combinations thereof.

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EVIDENCE APPENDIX

NONE

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RELATED PROCEEDINGS APPENDIX

NONE